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# **Conservation and Management of Lonar Crater Lake, An Ecological Wonder, Maharashtra, India**

**Ram Malu, D.S.Dhabade and M.S.Kodarkar\*,**

\* Secretary, Indian Association of Aquatic Biologists (IAAB), Hyderabad –500 095.  
R.A.Arts, M.K.Comm. & S.R.Rathi Science College,  
Wahim- 444 505, Maharashtra, India.

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## **ABSTRACT**

Lake Lonar, ranking third in the world among the craters created by meteorite impact, is located in the Buldhana district of Maharashtra, India. This crater lake is a unique inland saline ecosystem in South Asia and, unlike Arizona crater, a sterile wonder in the USA, it harbors an oasis of life. The lake ( $19^{\circ} 58' \text{ N}$ ,  $76^{\circ} 31' \text{ E}$ ) lies in a nearly circular depression and has five distinguishable zones, each exhibiting distinct geomorphic characteristics.

The crater basin is surrounded on all sides by a steeply rising escarpment (circularity index  $<0.9$ ) to an even height of about 130 m above lake level. Towards the north-east the scarp slope is breached by a deep gully that provides an easy access to the lake basin. Circumference of the lake basin along its outer rim is about 6 km, while along its inner rim, it is 3.5 km. The lake water is saline with maximum depth of brine being 5.5 m.

This land-locked lake is fed by seasonal drainage mainly confined to its periphery, and also three fresh water springs. Although the crater in itself is of immense interest as a geo-ecological wonder, what makes it still more unique is its salinity, high alkalinity and five to six micro ecosystems in it. The sub-ecosystems support a unique biodiversity due to localized variations in the conditions of soil, water and humidity. The Lonar ecosystem has evolved in a unique way due to the unusual geo-hydrological and climatic conditions. Apart from this the lake basin has eight major sites of archaeological and socio-religious significance.

In recent years the lake is undergoing eutrophication due to domestic sewage from fast developing Lonar town. Further, anthropogenic activities like constructions, washing and bathing and alterations in the basin are having an adverse impact on the lake. An integrated approach as advocated by Internationally accepted philosophy of Integrated Water Resources Management (IWRM) and seven principles proposed by World Lake Vision (WLV) is essential for long term sustainability of this ecologically, economically and culturally significant lake ecosystem.

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## **INTRODUCTION**

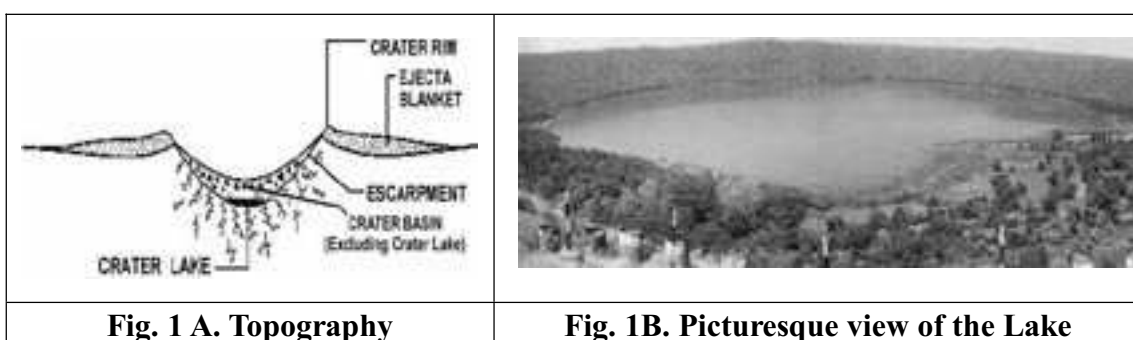
Often described as a geological wonder, Lake Lonar ranks third in the world among the craters created by meteorite impact, and is an ecosystem of immense interest. Unlike Arizona crater, a sterile wonder in America, Lonar harbors an oasis of life within its womb. Although the crater is of immense interest as a natural phenomenon, what makes it still more unique is the saline lake at its bottom. The lake water is of special quality with high salinity, alkalinity and five to six micro habitats inside it. The sub-ecosystems have a subtle combination of floral and faunal species due to

localized variations in the conditions of soil, water and humidity. The Lonar ecosystem has evolved in a unique way due to the unusual geo-hydrological and climatic conditions.

In the recent years, the lake is undergoing rapid environmental degradation and eutrophication due to domestic sewage from fast growing Lonar town. Further, anthropogenic activities like constructions, washing and bathing and alterations in the basin are having an adverse impact on the lake. In view of complex nature of governance involving many Governmental organizations, an integrated approach as advocated by Global Water Partnership (GWP) and seven principles proposed by World Lake Vision (WLV) is emphasized for long term sustainability of this ecologically, economically and culturally significant lake ecosystem.

### 1. Morphometry and hydrography (Fig. 1 A and B)

The Lonar crater Lake ( $19^{\circ} 58' \text{ N}$ ,  $76^{\circ} 31' \text{ E}$ ) lies in a nearly circular depression and has five distinguishable zones, exhibiting distinct geomorphic characteristics and hence requiring different conservation strategies. The zones include: (a) The outermost Ejecta Blanket, (b) The crater rim, (c) Slopes of the crater (d) Crater basin excluding the lake and (e) The crater lake.



The crater is surrounded on all sides by a steeply rising escarpment (circularity index  $<0.9$ ) to an even height of about 130 m above lake level. Towards the north-east the scarp slope is breached by a deep gully that provides an easy access to the lake basin. Circumference of the lake basin along its outer rim is about 6 km, while along its inner rim it is 3.5 km. The lake water is saline with maximum depth of brine being 5.50 m. (Table 1). Along the foot of the breached north-eastern face there is an alluvial fan, well wooded with custard apple trees.

**Table 1. Water quality of Lonar Lake (Dabhade, 2006).**

Parameter	Value in ppm except for pH
pH	10.5
Total Hardness	250
Chlorides	2750
DO	2.98
TDS	10975
Nitrates	10.97
Ammonia	10.69

Phosphates	2.72
BOD	152
COD	153

This land locked lake is fed by seasonal drainage mainly confined to its periphery and also by three fresh water springs. The biggest spring called “*Dhar*” (meaning continuously flowing water stream in Marathi, the local language) is at the head of the ravine on the north-eastern slope of the crater at the height of 630m. ‘*Sitanahani*’ (meaning the bathing place of *Sita*, the consort of Lord *Rama*, the mythological character in the epic *Ramayana*), is the second spring present along the same ravine at lower level. Third spring ‘*Ramgaya*’ (where Lord Rama performed his worship) occurs on the south-eastern face close to the water level in the lake.

## 2. Lonar Lake ecosystem

The Lonar crater lies amidst the vast monotonous plateau surrounding it from all the sides. The unique location has caused a localized transition in the important geographical, geological, climatic and ecological features. Being subterranean hollow closed from all sides, the lake is protected from heavy wind and retains higher level of humidity and a localized temperature regime. Due to typical geography, the lake basin gets partly screened from direct sunlight at different places and times of a day throughout the year. Being a low-level basin, the lake receives water apart from springs, also due to percolation.

Following are the characteristic geo-morphological features of the Lonar ecosystem:

1) Relative seclusion of the crater basin; 2) Higher humidity levels in the basin; 3) Higher ground-water levels in the basin; 4) Perennial fresh water springs; 5) Perennial salt water reservoir; 6) Sandy and silty lake shoreline; 7) Dry deciduous ecosystem around the crater; 8) Dry bushy vegetation on the rim and slopes; 9) Moist deciduous ecosystem in the basin with semi-evergreen components; 10) Luxuriant vegetation on the banks of perennial streams with evergreen components; 11) Salt tolerant vegetation along the lake shore; and 12) Microbial flora and fauna of the Crater Lake.

## 3. Controlling authorities

Lonar lake and its basin is under the administrative control of multiple authorities and good governance as envisioned in the principles of World Lake Vision (WLV) requires close cooperation and coordination among them. The authorities include:

- A. Lonar Municipal Council, which has a jurisdiction over the town, the agricultural areas within the crater basin and the agricultural lands within and beyond the sphere designated as the ejecta blanket.( 3550 ha.).
- B. The forest department owns and manages approximately 200 hectares of land within the crater and approximately 150 ha. within the ejecta blanket.
- C. The revenue department which collects the taxes from the agricultural lands inside the crater (approximately 21.26 ha.) and the private agriculture lands (approximately 300 hectares) which constitute the remaining segment of the ejecta blanket.

- D. The Public Works Department (PWD) is in charge of the roads entering and exiting Lonar town.
- E. The Irrigation Department which has constructed a percolation tank towards south-west direction of the crater falls partly within ejecta blanket.
- F. The Archaeological Survey of India (ASI) is technically charged with the responsibility of looking after the monuments and temples within the crater.

#### **4. Water and land use pattern**

Water of two main fresh water springs (*Dhar and Sita Nahini*) is used by the visiting pilgrims and the people of Lonar village for their domestic needs including drinking, bathing and washing. The freshwater springs are also harvested by local people for agriculture activities carried out in the lake basin. Water from third major spring (*Ramgaya*) is pumped by two schools located on the rim of the crater for drinking purpose.

About 21 ha. of fertile land at the base of the crater is used for agriculture purpose by the local farmers and the chief crops include vegetables, banana and papaya. Most of the 150 ha. land under the control of forest department is used for plantation.

### **HUMAN ACTIVITIES AND THEIR IMPACTS ON THE LAKE**

- A. Discharge of sewage in to the crater:** Solid and liquid waste from hotels and stalls in the vicinity of the lake is released directly into natural streams and ends up in to the lake. Similarly pilgrims use the *Dhar* stream for bathing and washing thereby generating effluents that finally enter the lake,
- B. Deforestation, hunting and cattle grazing:** Large scale deforestation and extensive grazing inside the crater is a common feature. This problem is mainly on account of agricultural activities right inside the crater. Unfortunately such an unregulated access leads to hunting of birds and other fauna.
- C. Bathing and washing activities in the freshwater springs:** Local inhabitants have been regularly using the *Dhar* water for washing and bathing purposes. The effluents thus generated ultimately not only pollute the lake water, but also sustain a eutrophic state of the ecosystem.
- D. Agriculture inside the crater:** The land, to the extent of 21.26 ha privately owned by 66 local farmers inside the crater, is under cultivation and use of pesticides, insecticides and inorganic fertilizers generate problems of toxicity and eutrophication of the lake.
- E. Religious fairs and rituals inside the crater:** There are twenty seven temples, three monuments, seven *kunds* (small temple tanks for bathing) and three inscriptions inside the Lake Lonar crater. All of these monuments belong to *Yadava* rulers and the medieval periods. Historically, religious fairs and rituals at many of these temples is a regular practice. For example, during *Navaratri* (a festival dedicated to worship of divine mother) around 150 thousand pilgrims visit *Kamaljadevi* temple. Although the festival is limited to 10 days, the impact is enormous on the lake ecosystem and a special challenge for effective management.

## 1. Impact of developmental activities by the Government Departments

The developmental activities undertaken by different Government agencies in and around Lonar crater and the lake have produced problems for sustainable management of the lake (Table 2).

- A. Irrigation Department:** In 1984 minor irrigation department constructed a percolation tank near *Deulgaon-Kundapal* village, about 2 km from Lonar crater in south-western direction. The tank impounds 83.8 m cm<sup>3</sup> of water and has total irrigation potential of 100 ha. However, the percolation tank and couple of other tanks in the vicinity of Lonar crater are partially responsible for the rise in the water level of the lake. The altering hydrology also has its adverse impact on the unique water quality. The rising water level is also damaging sites of archaeological importance in the crater.
- B. Forest Department:** During the period of 1986-92 the Forest department (Govt. of Maharashtra) carried out extensive plantation in the crater. The most surprising feature of this programme was plantation of unsuitable exotic species, *Prosopis juliflora* (locally called as *Vedibabhul*) right in the heart of the crater. This plant is dwarf, spreading type and extremely thorny. It is progressively encroaching inside the crater. Presently the *Prosopis* thickets have completely covered all temples on the crater floor and now it has become difficult even to reach some of them and even the lake shore. This species is now spreading towards the higher slopes of the crater and may adversely affect native flora and fauna.
- C. Public Works Department (PWD):** The Public Works Department (PWD) is recently working on a project for widening the road which at one point runs at a tangent to the crater and cuts through the Ejecta blanket. It is indeed unfortunate that the department has neglected the importance of the Lonar crater while fixing the alignment of the road in the initial stage and damage caused to geographical feature of the crater is irreparable.
- D. Lonar Municipal Council:** Provision of proper drainage and sewage management is the responsibility of Lonar Municipal Council. In the last few years Lonar township is growing very fast and for want of proper sewage treatment and disposal facilities, the waste water is getting into the lake leading to its gross pollution.
- E. Archeological Department:** Haphazard renovation work in some of the temples has led to a distortion and deterioration of the architectural and religious values of the protected monuments. Such thoughtless renovation by Archeological Survey of India (ASI) is adversely affecting aesthetic, socio-cultural and tourism value of Lonar ecosystem.

**Table 2. Impacts of Human Interventions on ecological and geo-morphological features of Lonar Lake.**

Human Interventions	Impact
Discharge of sewage	Pollution of lake water leading to increased organic load in the lake water

Use of detergent/pesticides/inorganic	Change in chemical composition of lake water fertilizers and crater soil Extinction of specially adapted species.
Tree cutting and cattle grazing	Deforestation, damage to ephemeral plants, dispersion of unwanted weeds, change in species composition, reduction in biodiversity, soil erosion.
Building steps/ tracking on slopes	Denudation and erosion of soil, reduction in crater wall gradient
Plantation of exotic species	Unpredictable change in species composition
Encroachment/ construction of buildings	Disfigurement of the rim and Ejecta Blanket in crater area/ ring road.
Construction of impoundments	Percolation of water into the crater lake, leading to an increase in the water level and changes in the water quality.
Commercial harvesting of materials	Pressure on the fragile ecosystem and irreversible losses.

## 2. Sustainable use of Lonar lake:

### A. International tourism - Sustainable Ecological Tourism (Eco-tourism):

Eco-tourism can be described as activities which are undertaken to satisfy the desire of the people to enjoy nature. Lonar is an ideal site for development of the eco-tourism. Besides being an ecological wonder and paradise of biodiversity including water fowls, the crater is spotted by ancient monuments. The temples unfortunately lie in decay and ruin. Nevertheless, their beauty and majesty cannot be ignored and utilized for encouraging eco-tourism after proper Environmental Impact Assessment (EIA) to reduce anthropogenic stress on the crater ecosystem.

### B. Source of *Spirulina*: *Spirulina*, a common blue green algae naturally occurs in the Lonar water. It is a rich source of proteins, vitamins and minerals. The lake water can be used for mass culture of *Spirulina* as a bio-industry..

### C. Source of Natural products: The flora and fauna of Lonar Lake has evolved over a period of time, and work needs to be carried out on the species with medicinal values. There is a need of an extensive survey of medicinal plant and animal species. In addition, the Lonar Lake crater needs to be declared a bioreserve and protected area.

## 3. Conservation plan

The Indian constitution has placed special emphasis on conservation of nature and, as per articles 48(A) and 51(A), has been made a fundamental duty of every citizen. The article 51 A reads as “It shall be duty of every citizen of India to protect and improve natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures. In addition, the convention on biological diversity was signed by India in 1992 and ratified by the Indian Parliament on the 18th February 1994. The IV World Congress on National Park and Protected Areas also contains sufficient guiding principles in this regard. Laws for protecting biological diversity in India are the Indian Forest Act, 1927; the Forest (Conservation) Act, 1980;

the Wildlife (Protection) Act, 1972 and the environmental Protection Act, 1986. In the light of guidance from Indian Constitution and country's International commitments, protection, conservation and sustainable management of Lonar crater ecosystem needs to be a priority for the State and Central governments.

**A. Identification of the geographical area for protection:** The area of Lonar crater and its precincts form approximately 730 ha. About half this area, i.e. 350 ha, is owned by the forest department, the revenue department controls 77 ha and the remaining 300 ha is private agricultural land. It is heartening to note that an area measuring 750 ha in and around the crater, is already declared as the National Park. The following is a list of suggested conservation measures:

1. Diversion of sewage drain (*Nabbi Nala*) entering the crater from north-eastern side to avoid eutrophication of the lake ecosystem.
2. Immediate reconsideration and modification of proposed *Lonar - Mantha* road widening plan by Public Works Department (PWD) so as to divert said road at least half km. away from the crater.
3. Imposition of ban on the use of chemical fertilizers, pesticides and other toxic materials in the agricultural activities in the crater.
4. Ban on use of detergent and soaps in bathing and washing activities at *Dhar* and other fresh water springs.
5. Strict prohibition on Tree felling, hunting and grazing inside the crater.
6. Complete eradication of *Prosopis juliflora* from the crater.
7. Detailed investigation of causes for decrease in salinity of lake water.
8. 'Florescent Test' to confirm percolation of water from the nearby irrigation tank into the crater lake.
9. Notification Lonar as Wildlife Sanctuary with peripheral bio-conservation zone. Lonar lake should be declared as the Ramsar site World Heritage Centre.
10. Appointment of qualified and well equipped staff to ensure an effective conservation of crater ecology.
11. Establishment of Visitor Management Center at Lonar for an effective regulation of the activities of local inhabitants, pilgrims, and tourists inside the crater.
12. Publication of a comprehensive document/ white paper about the crater, providing detailed and authentic information on all the important aspects of the lake ecosystem.
13. Ban on shops, stalls, etc., during religious fairs inside the crater.
14. Close watch on the relationship between water impoundments around the crater and the water level of Lonar Lake for preemptive, as well as ameliorative, measures during emergencies.
15. Henceforth, forestation in any part of the crater should include indigenous species only.
16. An exhaustive documentation on the biodiversity of crater ecosystem is needed.
17. Establishment of *Lonar Sarovar Samvardhini* (Lonar lake Conservation and Management Society) headed by the District Collector and comprising of

Government authorities, representatives of local citizens, NGOs, research scholars, academicians and other stakeholders.

## THE WAY FORWARD:

Over thousands of years Lonar ecosystem has evolved in a unique way due to the unusual geo-hydrological features and climatic conditions. However, the same conditions have made it extremely fragile and vulnerable to anthropogenic stress. The unique biotic zones resulting from such isolation need proper conservation and protection. The deterioration of Lonar Lake because of anthropogenic impacts has now reached a level where if the activities go on uncontrolled and unchecked, there is a great danger of permanent damage to the ecosystem in near future. Anything rare and extraordinary has the power to attract people towards it and the same principle is applicable to the Lonar Crater Lake which has a great tourist potential which has potential to immensely benefit this economically backward region.

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